

Remote sensing to detect source-to-sink dynamics

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Abstract

A brief overview of the keynote "Remote sensing to detect source-to-sink dynamics" planned for the 1st International Conference on Technological and Research Advancements in Coastal and Estuarine Systems 2025 (TRACE2025) is given here, via both a video and a short summary.

Key words: Remote sensing, satellite, source-to-sink dynamics

Remote sensing (RS) is becoming a paramount tool in analysing changes in the Earth's surface at multiple spatiotemporal scales, eventually providing input data for further modelling and analysis of different scenarios (Balsamo et al. 2018). The rapid advancements in technology have significantly expanded the capabilities of RS, and these technologies are becoming indispensable tools, with numerous industry applications increasingly being adopted as standard practice.

Remote sensing methods comprise a multitude of techniques such as large and miniaturised satellites, airborne sensors, LiDAR, uncrewed vehicles, interferometric synthetic aperture radars, various cameras, etc. Data acquired by RS is, from the aspect of the spatial extent, unmatched by any other method and therefore can improve the understanding and prediction of environmental processes. RS methods could be used not only directly, but also in combination with other data sources, in a fused/synergistic fashion, sometimes also including land-based sensor networks or even data from dedicated field campaigns (i.e. one source acting not only complementary to the other, but in a way to leverage the information obtained from all of them).

In water resources management, scholars and practitioners members are working with remote sensing methods on a daily basis, mostly by applying different types of RS methods. However, a common understanding of the potential and limitations of each is still limited also because of the lack of a common entry point. Key strengths and weaknesses can be identified only if they are approached from an interdisciplinary point of view, unravelling the overlapping knowledge gap.

Focusing on satellite data, one of the aspects of RS technologies, this keynote will revise past and ongoing studies that leveraged satellite information and datasets to depict fluvial and coastal dynamics at multiple spatiotemporal scales. Key concepts of satellite data will be first introduced, and then the dynamics of



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large watercourses such as the Vistula in Poland (Nones 2021) and the Po in Italy (Nones et al. 2024) will be analysed. The presented results point out a process of oversimplifications of those rivers, mainly as a consequence of changing hydrology due to a combination of human pressure and climate change. This oversimplification in planform morphology is accompanied by an overgrowing of riparian vegetation on bars and banks, further contributing to fixing the morphology. These two examples highlight the need to investigate future river dynamics at a large scale, especially in the light of climate change, as those dynamics could impact numerous local phenomena like bank erosion, water quality and infrastructure stability.

Moving from evaluating planform and vegetation dynamics to the analysis of sediment transport, an ongoing study on the Changjiang River in China will be presented, showing the potential of using remote sensing for extrapolating local information on suspended sediment transport towards an extensive mapping of suspended sediment concentration dynamics, which might reveal very important in the management of man-made structures like hydropower reservoirs or for ecological reasons. This innovative application of coupling satellite data with in-field sampling in turbulent rivers shows the large potential that remote sensing could have on our lives, and how these tools could be applied to depict dynamics usually not captured with traditional methods.

Besides applications in fluvial environments, the keynote will focus also on transitional areas such as bays. As a case study, the Ha Long Bay in Vietnam was selected, being a renovated tourist area suffering from depletion of water quality (Quang et al. 2025). The combination of remote sensing and machine learning applied on this area highlighted that water quality in the bay is highly impacted by seasonality, which is also connected to the presence of tourists as well as urban activities, aquaculture and industry.

By providing a series of examples spanning multiple environmental compartments, this keynote aims to provide evidence on the potential of using satellite data to depict source-to-sink dynamics, meaning to describe the processes that transport and deposit materials from their source (e.g., mountains, rivers, or coastline) to their sink (e.g., oceans, basins, or floodplains). Satellite data helps provide a comprehensive view of source-to-sink dynamics by offering large-scale, continuous, and detailed observations. These insights are crucial for understanding natural processes, managing environmental change, and informing policy decisions related to land and water resource management.

Additional information

Conflict of interest

The author has declared that no competing interests exist.

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Author contributions

The author solely contributed to this work.

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Data availability

All of the data that support the findings of this study are available in the main text or Supplementary Information.

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Supplementary material 1

Supplementary video

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Data type: mp4

Explanation note: The video link: <https://youtu.be/mDsxcuFsgHY>

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